DOCKET NO.: THOM-0015 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:
Barry James Lytollis

Serial No.: 09/894, 099 Group Art Unit: 2836

Filing Date: June 28, 2001 Examiner: Not yet assigned.

For: Protection of Intrinsically Safe Circuits

DATE OF DEPOSIT: November 5, 2001

I HEREBY CERTIFY THAT THIS PAPER IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE AS FIRST CLASS MAIL, POSTAGE PREPAID ON THE DATE INDICATED ABOVE AND IS ADDRESSED TO THE ASSISTANT COMMISSIONER FOR ~~PATENTS~~, WASHINGTON, DC 20231.

TYPED NAME: Steven J. Rocci
REGISTRATION NO. 30,489

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☐ AF

Assistant Commissioner for Patents
Washington DC 20231

Sir:

TRANSMITTAL LETTER

Transmitted herewith for filing in the above-identified patent application is:

☐ A Preliminary Amendment.

☐ An Amendment Responsive to the Office Action Dated _____.

☐ An Amendment Supplemental to the Paper filed _____.

☐ Other: _____.

☐ Applicant(s) has previously claimed small entity status under 37 CFR §1.27.

☐ Applicant(s) by its/their undersigned attorney, claims small entity status under 37 CFR §1.27 as:

☐ an Independent Inventor

☐ a Small Business Concern

☐ a Nonprofit Organization

☐ This application is no longer entitled to small entity status. It is requested that this be noted in the files of the Patent and Trademark Office.

☐ Substitute Pages _____ of the Specification are enclosed.

☐ An Abstract is enclosed.

☐ _____ Sheets of Proposed Corrected Drawings are enclosed.

☒ A Certified Copy of each of the following applications: Certified Copy of priority document no. **GB0016524.1** filed **07/06/00** in the **United Kingdom** is enclosed.

☐ An Associate Power of Attorney is enclosed.

☐ Information Disclosure Statement.

- ☐ Attached Form 1449.
- ☐ A copy of each reference as listed on the attached Form PTO-1449 is enclosed herewith.

☐ Appended Material as follows: _____.

☐ Other Material as follows: _____.

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FEE CALCULATION

☒ No Additional Fee is Due.

				SMALL ENTITY		NOT SMALL ENTITY	
	REMAINING AFTER AMENDMENT	HIGHEST PAID FOR	EXTRA	RATE	FEE	RATE	FEE
TOTAL CLAIMS	13	20 (20 MINIMUM)	0	$9 EACH	$	$18 EACH	$0
INDEP. CLAIMS	3	3 (3 MINIMUM)	0	$42 EACH	$	$84 EACH	$ 0
FIRST PRESENTATION OF MULTIPLE DEPENDENT				$140	$	$280	$ 0
☐ ONE MONTH EXTENSION OF TIME				$55	$	$110	$0
☐ TWO MONTH EXTENSION OF TIME				$200	$	$400	$0
☐ THREE MONTH EXTENSION OF TIME				$460	$	$920	$0
☐ FOUR MONTH EXTENSION OF TIME				$720	$	$1440	$0
☐ FIVE MONTH EXTENSION OF TIME				$980	$	$1960	$0
☐ LESS ANY EXTENSION FEE ALREADY PAID				minus	($)	minus	($ 0)
☐ TERMINAL DISCLAIMER				$55	$	$110	$0
☐ OTHER FEE OR SURCHARGE AS FOLLOWS:							0
TOTAL FEE DUE							$0

☐ A Check is Enclosed in the Foregoing Amount Due.

☐ Petition is hereby made under 37 C.F.R. 1.136(a) to extend the time for response to the Office Action of @@ to and through @@ comprising an extension of the shortened statutory period of @@ month(s).

☒ The Commissioner is hereby requested to grant an extension of time for the appropriate length of time, should one be necessary, in connection with this filing or any future filing submitted to the U.S. Patent and Trademark Office in the above-identified application during the pendency of this application. The Commissioner is further authorized to charge any fees related to any such extension of time to deposit account 23-3050. This sheet is provided in duplicate.

☒ The Commissioner is authorized to charge payment of the following fees and to refund any overpayment associated with this communication or during the pendency of this application to deposit account 23-3050. This sheet is provided in duplicate.

☐ The Foregoing Amount Due for Filing this Paper.

☒ Any additional filing fees required, including fees for the presentation of extra claims under 37 C.F.R. 1.16.

☒ Any additional patent application processing fees under 37 C.F.R. 1.17 or 1.20(d).

SHOULD ANY DEFICIENCIES APPEAR with respect to this application, including deficiencies in payment of fees, missing parts of the application or otherwise, the United States Patent and Trademark Office is respectfully requested to promptly notify the undersigned.

Date: November 5, 2001

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The Patent Office

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

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Signed: [redacted]

Dated: 19 June 2001

Patents Form 1/77

Patents Act 1977
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Request for grant of a patent

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06 JUL 2000

The Patent Office

Cardiff Road
Newport
Gwent NP10 8QQ

1.	Your reference	RBT/P300584GB
2.	Patent application number *(The Patent Office will fill in this part)*	**0016524.1**
3.	Full name, address and postcode of the or of each applicant (*underline all surnames*)	The MTL Instruments Group plc Power Court Luton Bedfordshire LU1 3JJ
	Patents ADP number (*if you know it*)	70192663001
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4.	Title of the invention	PROTECTION OF INCENDIVE CIRCUITS
5.	Name of your agent (*if you have one*)	**W. P. Thompson & Co.**
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Eastcheap House, Central Approach Letchworth Herts SG6 3DS
	Patents ADP number *(if you know it)*	158003

6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number *(if you know it)*	Date of filing *(Day/month/year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application		Date of filing *(Day/month/year)*
8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	Yes		

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	6
Claims	
Abstract	
Drawing(s)	2+2

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(Please specify)*	

11. We request the grant of a patent on the basis of this application

Signature W.P. Thompson & Co. Date July 5, 2000

W. P. Thompson & Co.

12. Name and daytime telephone number of person to contact in the United Kingdom: Roger B Thomson **01462 682139**

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 01645 500505*

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c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

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PROTECTION OF INCENDIVE CIRCUITS

This invention relates to the protection of potentially incendive circuits. It is particularly concerned with the protection of circuits which operate within hazardous areas, for example in the presence of flammable gases.

In systems where power supplies feed a number of functional modules, where there may be the presence of flammable gases, there is a need to ensure that the system is safe. This means that the wiring between the power supplies and the modules must be protected in some way so that it is not incendive, even when the modules are unplugged with the system running. One way to achieve this is to use Exi protection, with the power supplies having electronic power limiters in each output. These power limiters define the maximum output voltage and limit the short-circuit current. However, these limiters are quite complex because they must meet the conflicting requirements of being precise yet operate fast. This complexity is duplicated to meet the fault-count requirements for Exib.

It is an object of the present invention to provide a means of protecting potentially incendive circuits using a simpler system than the relatively complex, conventional powerlimiters.

It is a further object of the invention to provide means whereby one affords complete protection to the wiring and to any plugs and sockets along the way. Desirably, provided that the inductance and capacitance limits are not exceeded, the wiring from the power supply to the modules is protected from open-circuit and short-circuit faults, so that no special segregation is required.

Since the wiring is wholly contained within the 1/1 node, the segregation between conductors can be controlled in the construction of the circuitry. If this segregation is made infallible, then short-circuit faults need not be considered and one only needs to protect against series breaks. For this, simpler protection schemes are adequate.

If one is concerned only with series breaks, then this removes the constraint to put the electronic protection upstream from the wiring to be protected. It simply has to be somewhere in series with the circuit. The importance of this to achieving protection in accordance with the invention will be apparent from the description given hereinafter.

In order that the invention may be more fully understood, a transistor switch system in accordance with the invention will now be described by way of example and with reference to the accompanying drawings. In the drawings:

Fig. 1 shows a known example of the use of an active voltage and current limiter to protect against wiring shorts and breaks;

Fig. 2 illustrates the concept underlying the present invention, in which the voltage and current which is sensed upon a break in the wiring opens a switch;

Fig. 3 is a circuit diagram showing a more practical arrangement in accordance with the invention;

Fig. 4 shows a transistor switch circuit which can be used in accordance with the invention; and

Fig. 5 shows a circuit in accordance with the invention for testing purposes.

The circuit shown in Fig. 1, to illustrate the prior art, has a voltage supply 10, a load 12 and an active voltage and current limiter 14 upstream from the load. A pin 16

illustrates a short-circuit condition and a break in the wiring is indicated at 18. The active limiter 14 shown in Fig. 1 protects by limiting the voltage and current which is available to the circuit below a known incendive limit. However, this is not strictly necessary. What is required is to restrict the voltage and current which is available to a developing spark to levels below the incendive limit.

Fig. 2 illustrates this concept. A1 is a voltage sensor, sensing the voltage developed across the break 18 in the circuit. A2 is a current sensor, sensing the current flowing through it. The two sensors A1 and A2 are combined in a manner which will enable a switch 20 to open before the V/I characteristic exceeds the incendive limit. It is to be noted that the power available to the load 12 is not now constrained to be below the incendive limit.

It is also to be noted that the circuit shown in Fig. 2 merely illustrates the concept underlying the present invention. In particular, only the wiring between the inputs of voltage sensor A1 is protected.

Fig. 3 shows a more practical arrangement in which all of the circuit to the left-hand side of the voltage sensor A1 is now protected. Voltage sensor A1 now senses the voltage at the load end of the circuit, protecting all the wiring to its left. The voltage supply 10 is now added to the voltage sensed by voltage sensor A1, but is constant and allowance can be made for it. More importantly, the current sensor A2 is omitted and the output of the voltage sensor A1 is taken directly to the switch 20. It is known that for hydrogen, the most incendive gas group, it is impossible to get ignition with a voltage which is less than about 8 volts at any current, provided that the current is insufficient to cause

hot or molten metallic particles to be thrown off from the sparking contact. If the voltage which is allowed to develop across a breaking contact is restricted to less than 8 volts, then a precise current limit is not required. In some apparatus, it may be possible to rely on the nature of the load 12 to determine the maximum current.

The circuit shown in Fig. 3 will only be effective if the voltage sensor A1 and the switch 20 are sufficiently fast. Experience in the use of active limiters suggests that the protection must operate within a few microseconds. Research has been reported which suggests that the minimum spark duration capable of causing ignition is around 8μs. A transistor operating in a common-base configuration can be much faster than this and can be configured in a simple circuit which combines both the sensing and switching functions. Fig. 4 shows this in outline.

In Fig. 4 which shows a common-base transistor switch 20, a zener diode Z1 is connected to the base of the transistor. The voltage of zener diode Z1 is selected so that, when the circuit is unbroken, the supply voltage is present at the emitter of the switch 20 and base current is drawn through the zener diode Z1. The transistor switch 20 is turned hard on and current is fed to the load 12. If a break occurs, as indicated at 18, voltage is dropped across the break as a spark develops, resulting in the emitter voltage of the transistor 20 dropping. At the point when the emitter voltage drops below the zener voltage, plus the emitter-base drop, the transistor 20 will turn off and break the circuit.

Fig. 5 shows a circuit which embodies these principles. A series diode 22 is connected between the emitter of transistor 20 and the voltage supply 10. A resistance R1 is

connected between the base of the transistor 20 and the zener diode Z1. A second resistance R2 is connected between the emitter and base of the transistor 20. The resistance R1 limits the base current through transistor 20 to about 15 mA.

In one practical test circuit to this design, a load of 26 ohms was used, giving a load current of about 850mA, which is normally incendive in a constant current circuit down to around 12 volts or so.

The circuit was spark ignition tested according to EN 50020, using the 21% hydrogen in air explosive test mixture specified for group IIC gases. During this test, the power supply voltage was held constant at 24V, while the voltage of the zener diode Z1 was progressively reduced until ignition occurred. At the same time, resistor R1 was adjusted to maintain the current through zener diode Z1 to about 15mA. The effect of reducing the zener diode voltage in this way was to increase the voltage across the spark before transistor 20 turns off.

There were no ignitions until the spark voltage exceeded about 12V, demonstrating that the circuit does provide the expected protection.

In another test the spark V/I characteristics were monitored using a storage oscilloscope and a current probe. Many sparking events were monitored and none showed voltage and current simultaneously present at the spark, at a resolution down to below 1μs. This demonstrates the inherent speed of the common-base circuit.

This protective circuit in accordance with the invention is very simple, inherently fast, and can be easily cascaded to meet Exib fault-count requirements.

In a practical embodiment, the transistor 20 would be

protected against the over-dissipation which would occur if the input voltage happened to be just enough to bias it into its linear region. This can be achieved by adding a simple current limit, or by designing hysteresis into the switching action.

In a practical embodiment it would also be necessary to limit the current, to limit the inductive energy in the wiring. If the load circuitry will not suffice, then a simple current limit may be necessary, or, if the volt-drop can be tolerated, an infallible series resistor may be sufficient. It would also be necessary to include a fuse to protect against sustained overcurrent faults, which would cause thermal ratings to be exceeded.

Fig. 1.

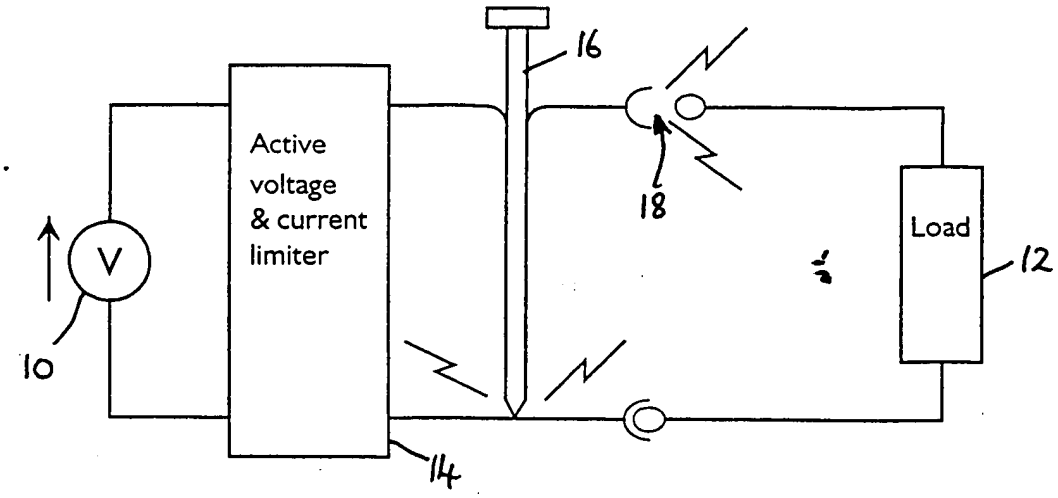

Fig. 2.

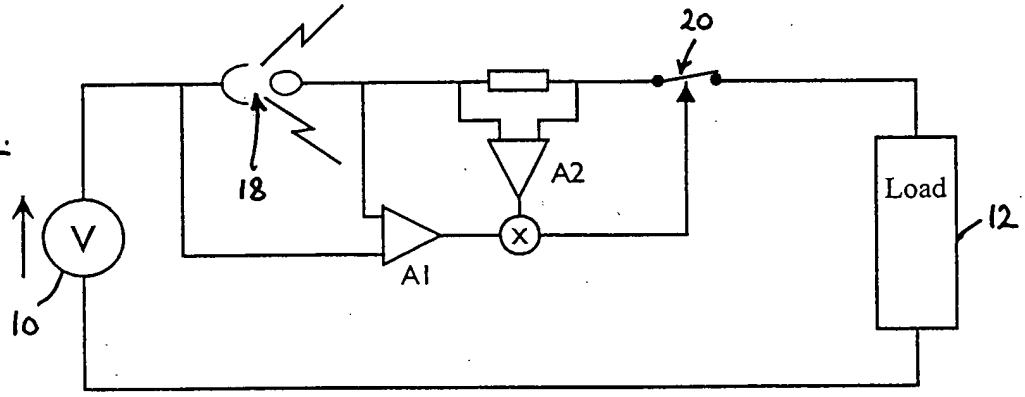

Fig. 3.

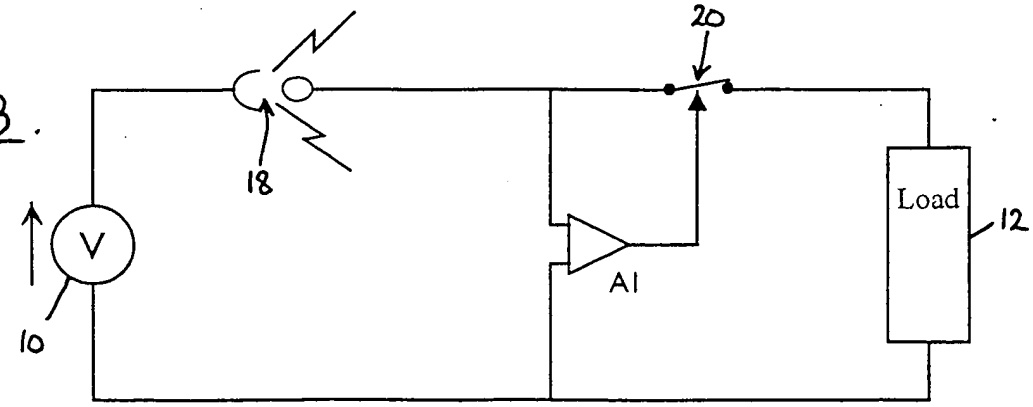

Fig.4.

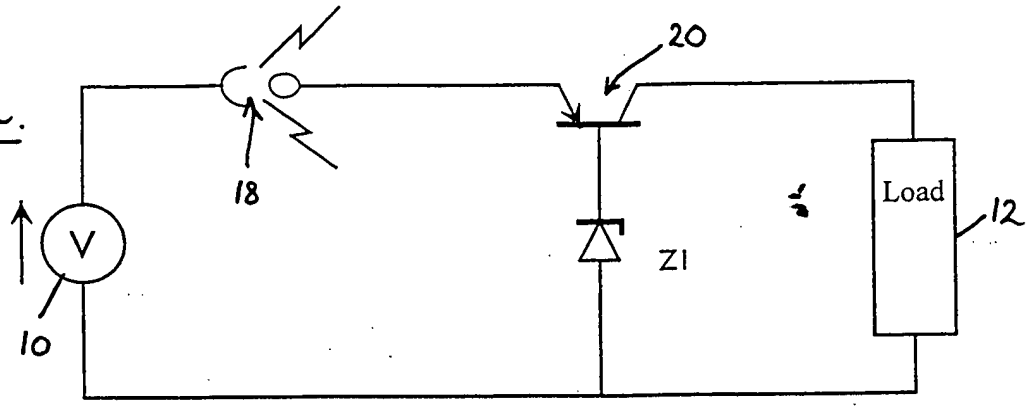

Fig.5.